IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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In re Application of: :
Kouji Amintani Art unit: 3736
Serial No.: 10/776,410 :
Filed: February 10, 2004
For: RADIOGRAPHING APPARATUS
:
_____x

DECLARATION

Honorable Commissioner of Patents
and Trademarks
Washington, D.C. 20231

Sir:

I, Masahiro SUGISAWA hereby declare and say as follows:

I am familiar with both the English and Japanese languages and I have compared the annexed English translation with the Japanese specification of Japanese Patent Application No. 2003-039808.

To the best of my knowledge and belief, the annexed English translation is an accurate translation of the above Japanese application.

The undersigned declares further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with

the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the U.S. Code and that such willful false statements may jeopardize the validity of the above-identified application or any patent issuing thereon.

Masahiro SUGISAWA

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[List of Documents Attached]

[Title of Document] Specification 1

[Title of Document]	Drawings	1
[Title of Document]	Abstract	1
[General authorization No.]	9001819	
[Necessity of proof]	Necessary	

[NAME OF DOCUMENT] SCOPE OF PATENT CLAIMS

[Claim 1] A radiation image photographing apparatus according to the invention described in Claim 1 comprising:

a photographic object table supporting a photographic object so that face to face against a radiation source;

a radiation image information detection component detecting a radioactive ray passing through the photographic object;

an absorption contrast image support table supporting the radiation image information detection component arranged to locate the radiation image information detection component at vicinity to the photographic object table and on opposite side of the radiation source for the photographic object when photographing an absorption image; and

a phase contrast image support table supporting the radiation image information detection component with a certain distance from the photographic object table arranged to locate the radiation image information detection component on the opposite side of the radiation source for the photographic object and at least a part of the radiation image information detection component is exposed inside irradiated area of the radiation source;

the radiation image photographing apparatus is characterized

in that a phase contrast image support table equipped with a supporting unit is attached detachably to a mammography unit.

[Claim 2] In a radiation image photographing apparatus described in Claim 1 is characterized in that the weight of the supporting unit is less than 30 Kg.

[Claim 3] In a radiation image photographing apparatus described in Claim 1 or 2 is characterized in that a grip handle is equipped with the supporting unit.

[Claim 4] In a radiation image photographing apparatus described in any one of Claims 1 to 3 is characterized in that the supporting unit and the mammography unit are connected electrically.

[Claim 5] In a radiation image photographing apparatus described in any one of Claims 1 to 4 is characterized in that the phase contrast support table attached to the supporting unit is positioned to secure a space at the opposite side of the radiation source against the photographic object table, in which the phase contrast support table to be evacuated at the opposite side of the radiation source against the photographic object table.

[NAME OF DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] RADIATION IMAGE PHOTOGRAPHIC APPARATUS

(0001)

[FIELD OF THE INVENTION]

This invention relates to a radiation image photographing apparatus especially relates to a radiation image photography apparatus which enables a phase contrast photography.

(0002)

[PRIOR ART]

A radiation image photographing apparatus, which generally uses the action, which radioactive rays pass through a substance, is widely used for medical image diagnostics, non-destructive tests, etc. Especially, in regard to radiation image photographing apparatus for mammography used for photography of a specific part of human body, a method that a photographic object is usually fixed on the photographic object table united with a radiation image detection component and photographed, has been performed. However, although a photographic object was photographed in about same size as the photographic object according to this method, there was a problem that the clearness of the image

was inadequate as photographing apparatus for medical treatments used in order to read out the detailed structure of a specific part of a human body since the photographic contrast may not be good enough.

(0003)

It has been known that a radiation tube (a small focal sized radiation source whose focal point size is 30-300μm) was used in order to obtain phase contrast photography. (Refer to patent reference No.1) According to this, compared with the image of only usual absorption contrast, the contrast of photographic object's boundary can be described highly and it becomes possible to obtain a high definition radiation image more vividly. However, when obtaining a phase contrast image, it is necessary to establish a fixed distance between a photographic object and a radiation image information detection component. Moreover, if a field of cost concerning standpoint and apparatus, which mitigate the examinee's burden in the medical spot, is taken into consideration, a thing which photos the image of not only "phase image photography mode" that photos a phase contrast image but also "absorption contrast mode" that generally photos only an absorption contrast image, for which the same radiation image photographing apparatus can usually perform

both of photographic modes, is desirable.

(0004)

Therefore, for example, in prior art, by arranging a radiation image information detection component for an absorption contrast image attached detachably right under or right above the photographic object table to fix a photographic object and also a detection component support table on which another radiation image information detection component was attached detachably under the photographic object table with keeping a fixed distance between a radiation image information detection component for phase contrast image and a photographic object. Thereby, a same radiation image photographing apparatus was arranged to have two modes, phase photographing mode and normal photographing mode, by switching a setting location of the radiation image information detection component between the detection component support table and vicinity to the photographic object table.

(0005)

[Patent reference No 1.]

Japanese published patent application 2001-23871

(0006)

[PROBLEM TO BE SOLVED BY THE INVENTION]

However, in the case of normal photographing mode, an examinee tends to hit his or her body to a detection component support table since the detection component support table is located right under the photographic object table even though the radiation image information detection component is not necessary. Especially when an examinee is photographed sitting on a chair or a wheelchair, a detection component support table is going to be an obstacle to the examinee and sometimes the examinee has to stand up to be photographed, which is a heavy burden to the examinee.

(0007)

It is an objective of this invention to provide a radiation image photographing apparatus having the above drawback obviated and a detection component support table set at a location where the existence of the detection component support table to hold the radiation image information detection component for phase contrast photographing not to be an obstacle to the examinee and decrease the examinee's burden.

(0008)

[MEANS FOR SOLVING THE PROBLEM]

In order to solve the problem above and achieve the objectives of this invention, this invention comprises as

following.

(0009)

A radiation image photographing apparatus according to the invention described in Claim 1 comprises:

a photographic object table supporting a photographic object so that face to face against a radiation source;

a radiation image information detection component detecting a radioactive ray passing through the photographic object;

an absorption contrast image support table supporting the radiation image information detection component arranged to locate the radiation image information detection component at vicinity to the photographic object table and on opposite side of the radiation source for the photographic object when photographing an absorption image; and

a phase contrast image support table supporting the radiation image information detection component with a certain distance from the photographic object table arranged to locate the radiation image information detection component on the opposite side of the radiation source for the photographic object and at least a part of the radiation image information detection component is exposed inside irradiated area of the radiation source;

the radiation image photographing apparatus is characterized in that a phase contrast image support table equipped with a supporting unit is attached detachably to a mammography unit.

(0010)

According to the invention of Claim 1, the supporting unit equipped with a phase contrast image table is detached (can be moved or removed freely) to a mammography unit when absorption image is photographed so that a phase contrast image support table cannot be an obstacle and it gives fewer burdens to an examinee.

(0011)

A radiation image photographing apparatus according to the invention described in Claim 2 is characterized in that the weight of the supporting unit is less than 30 Kg in the radiation image photographing apparatus according to Claim 1.

(0012)

According to the invention of Claim 2, the weight of supporting unit is light enough (less than 30Kg) to attach or detach the supporting unit safely and gives fewer burdens to the examinee.

(0013)

A radiation image photographing apparatus according to

Claim 3 is characterized in that a grip handle is equipped with the supporting unit in the radiation image photographing apparatus according to Claim 1 or Claim 2.

(0014)

According to the invention of Claim 3, a grip handle is attached on the supporting unit so that the supporting unit can be attached or detached easily and safely and gives fewer burdens to an operator of the apparatus.

(0015)

The radiation image photographing apparatus according to Claim 4 is characterized in that the supporting unit and the mammography unit are connected electrically in a radiation image photographing apparatus according to either Claim 1 or claim 3.

(0016)

According to the invention of Claim 4, the supporting unit and the mammography unit are connected electrically so that a status of the supporting unit attached or detached can be easily detected at mammography unit in the case of that a sensor to detect the supporting unit attached or detached from the mammography unit and the malfunction can be prevented in advance. Furthermore, the phase contrast image support table attached to the supporting unit can be operated

from the mammography unit through remote control operation. Furthermore, the phase contrast image support table can be moved to a certain position or be made to evacuate when it is not used.

(0017)

The radiation image photographing apparatus according to Claim 5 is characterized in that the phase contrast support table attached to the supporting unit is positioned to secure a space at the opposite side of the radiation source against the photographic object table, in which the phase contrast support table to be evacuated at the opposite side of the radiation source against the photographic object table.

(0018)

The radiation image photographing apparatus according to Claim 5, when an absorption contrast image is photographed, in other words, when the phase contrast support table is not used, it can be evacuated into the space to prevent to be obstacle to the examinee, accordingly it reduces a load factor to attach or detach the phase contrast support table to the supporting unit.

(0019)

[EMBODIMENT OF THE INVENTION]

The embodiments of this invention are explained as

following by referring drawings attached. FIG.1 shows the side evaluation of a radiation image photographing apparatus and FIG.2 shows the side evaluation of a mammography unit of this invention respectively.

(0020)

A phase contrast image support table 14 equipped with a supporting unit 5 is detached to a photographing unit 2 in a core of a mammography unit 41. A photographing unit 2 is supported by a backing axis 4 equipped in a backing base 3, and it is desirable that a backing axis 4 is attached to be moved up and down to adjust its height according to the requirements from variety of photographing methods, differences of body form such as height of the examinee or a posture of examinee such as riding on a wheelchair or not. A backing base 3 is connected with a radioactive ray operation panel 37, which is used for switching photographing modes, and a power supply 36 as a driving source.

(0021)

A radiation source 6, irradiating a radioactive ray, is attached at upper side portion of a photographing unit 2 and a radioactive ray tube whose focal point is 30-2000μm, widely used at general medical facilities, is used as a radiation source. In detail, a radioactive ray tube whose wavelength is

about 0.1 nm is used. A radioactive ray is irradiated by energy conversion from kinetic energy to irradiated energy, which is obtained by a collision of electrons generated by thermal excitation and accelerated by high voltage to a cathode. When a radiation image is taken, this accelerated voltage corresponding to an exposure time, volume of electrons generated corresponding to a tube current and radioactive ray irradiated time corresponding to exposure time are set. Selecting a material of an anode from group of cupper, molybdenum, rhodium, and tungsten etc can change a radiation energy spectrum irradiated. When cupper, molybdenum, or rhodium is used as material of the anode of the radioactive ray tube, radioactive ray having a relatively low energy distribution with narrow distribution bandwidth can be obtained and by utilizing this characteristics, it is used for mammography having functions such as radiation diffraction crystal analysis and reading a detailed structure. When tungsten is used for an anode of a radioactive ray tube, radioactive ray obtained has relatively wide spectrum with high energy and can be used for a radiation photograph for chest, abdominal and head portion of human body, and nondestructive inspection in general industrial applications. It is distinctive that radiation dose irradiated is high when

used in medical and industrial applications. In these cases, high volume of electron hits at an anode terminal with high speed accordingly temperature of the anode terminal goes high enough to melt anode plate itself. In order to avoid this drawback, an anode is rotated to change the collision spot. In other words, it is normal to use a rotary anode terminal. It is desirable to use molybdenum, rhodium or tungsten for rotary anode in radioactive ray tube since photographical apparatus shown in this embodiment is designed for medical applications or nondestructive inspections.

(0022)

Here, a focal point of radioactive ray is considered a window viewed from a photographic object to take out radioactive ray generated by collision of electrons against a rotary anode in a radial tube. In general, a shape of a focal point is square and length of a side of the square corresponds to the size of the focal point. When a shape of focal point is a circle, it corresponds to a diameter of the circle and when the shape of the focal point is a square, it corresponds to a length of the square. Measuring methods such as by a pinhole camera and by a micro chart is explained in JIS (Japanese Industrial Standards) Z4704.

(0023)

A lower limit of focal point size of radioactive ray used is determined by the condition that a certain level of radiation dose is required to obtain a clear image without blur, and an upper limit of focal point size of radioactive ray used is determined by following factors such as distance between the photographic object 8 and radiation image information detection component 20 distance between focal point and photographic object 8 or physical characteristics of radioactive ray optimized to obtain a highly sharp image by emphasizing edges (phase contrast emphasized) on a boundary portion of photographic object 8 caused by the diffraction effect of radioactive ray. In order to practice a phase contrast photographing at normal medical facilities, the size of focal point is required between more than 30 μm and less than 300 μm, further more, preferably, between more than 30 μm and less than 200 μm.

(0024)

A grip bar 9 which an examinee uses to hold ones body may be attached on both sides of photographing unit 2 and a face guard is attached on photographing unit 2 facing toward an examinee. A photographic object table 10 which supports photographic object 8 from lower side and a pressure plate 11 is set as moving up and down freely to give pressure and fix

the photographic object 8, are provided perpendicularly to and under radiation source 6. Further more, it is recommended that photographic object table 10 is a rectangular flame or a rectangular flame with a transparent and thin plastic plate slicked on it.

(0025)

In this embodiment, supporting unit 5 with phase contrast image support table 14 attached is furnished detachably to core of a mammography unit 41. Accordingly, it may be removed when it is not used.

(0026)

When used, in this embodiment, one or a plural phase contrast image support table 14 attached on supporting unit 5 is arranged to be located at a point on a line drawn about perpendicularly from radiation source 6, and so that face to face as to radiation source 6. On each phase contrast image support table 14, a radioactive ray image information detection component 20 as a detection means to detect radioactive ray image information based on radioactive ray passed through a photographic object 8 and reached, is installed detachably. A radioactive ray irradiated from a radiation source 6, passing through a photographic object 8, can be observed as radiation energy (radiation image

information) on the radiation image information detection component 20.

(0027)

Besides phase contrast image support tables, absorption contrast image support table 13 is provided under photographic object support table 10 when an absorption contrast image is photographed.

(0028)

And in this embodiment, for example, an absorption contrast image support table 13 is arranged at a position R1 which corresponds to 55-70 cm from radiation source 6, on lower surface of photographic object support table 10, and a phase contrast image support table 14a is arranged at position R2 which corresponds to 0.5-1.5 times as much long as R1, from position R1 and further lower position, a phase contrast image support table 14b is arranged at position R3 which is 0.3-1.0 times as long as R1 from position R2.

(0029)

In this embodiment, an absorption contrast image support table 13 is mounted on lower side surface of photographic object table 10 without space in between however, it is possible to install a radiation image information detection component 20 at any position, vicinity of photographing

object table 10, for example on the surface of photographing object table 10 or inside of it, in the case that the radiation image information detection component is located at the other side of radiation source of photographing object table 8 and within the range which absorption contrast image can be photographed. Also it is not necessary to have a photographing object table 10 and an absorption contrast image support table 13 separately since using a photographing object table 10 as an absorption contrast image support table can support radiation image information detection component 20.

(0030)

A grid (not shown) can be provided to prevent scattering radioactive ray, which might effect on photographing at radiation source 6 side of radiation image information detection component 20. However the grid may not be provided on the radiation image information detection component 20 attached to a phase contrast image support table 14 since scattering radiation dose is decreased as the distance from photographing object table 8 increases.

(0031)

A supporting unit 5 as shown in FIG.3, is fixed to a photographing unit 2 as to fix the upper potion of supporting

unit 5a to lower portion of the photographing unit 2 by putting a clamping component 50 to lower portion of the photographing unit 2. As mentioned above, a supporting unit 5 is simply and surely detached by using clamping component 50. It is believed that a burden to detach a supporting unit 5 can be decreased, and moving and removing can be done safely since the weight of a supporting unit is so light as less than 30 Kg.

(0032)

And, a grip handle 51 is provided at the center portion of a supporting unit 5 as shown in FIG.4. A supporting unit 5 can be simply and surely detached by using a grip handle 51 when detaching supporting unit 5 on photographing unit 2. So it is believed that a burden to detach a supporting unit 5 can be decreased and it can be done safely since a supporting unit 5 has a grip handle.

(0033)

And a supporting unit 5 and a core of a mammography unit 41 as shown in FIG.5, are connected electrically. This electrical connection is done by attaching a supporting unit 5 to photographing unit 2 then connecting an electric connector 55a on the supporting unit 5 to an electric connector 55b on the photographing unit 2. As explained above,

as supporting unit 5 and a core of a mammography unit 41 are connected electrically, an electric connector 55a which detects a supporting unit 5 detached and electric connector 55b having a sensor are provided, then the status of supporting unit 5 detached can be recognized and a malfunction can be prevented in advance.

(0034)

And phase contrast image support table 14 attached on the supporting unit 5 can be controlled by remote operation to be moved to a certain position or to be evacuated when the phase contrast image support table is not used.

(0035)

In this embodiment, the phase contrast image support table 14 attached on the supporting unit 5 can be evacuated to secure the space from the point where a phase contrast image is photographed to the opposite side of the radiation source against the photographic object table 10.

(0036)

In regard to system, which enables the evacuation, there are several systems such as detachable system, foldable system and sliding system. In this embodiment, foldable system is employed for phase contrast image support table 14 so that the phase contrast image support table 14 can be

evacuated from photographing position without detaching it. In other words, the burden on the operator can be decreased since phase contrast image support table 14 can be evacuated to the position, which is not going to be an obstacle to the examinee. Also it is not necessary to secure the space to install phase contrast image support table 14 since it is not necessary to dismount the phase contrast image support table 14.

(0037)

When an absorption contrast image is photographed, in other words, when the phase contrast image support table is not used, mounting and dismounting workload can be decreased since the phase contrast image table 14 can be evacuated to the position where the phase contrast image support table is not going to be an obstacle to the examinee without dismounting the supporting unit 5.

(0038)

In this embodiment, supporting unit 5 having a phase contrast image support table 14 can be detached to the mammography unit 41 as shown in FIG.2. Specifications for the mammography unit 41 are as follows. However this invention is not limited to

(0039)

In regard to setting range for photographing condition, when a small focal point is selected, 2 mAs - 200 mAs, 22 kV - 35 kV, when a large sized focal point is selected, 2 mAs - 600 mAs, 22 kV - 39 kV.

(0040)

In regards to an additional filter, when tube voltage is set at 35 kV 0.03 mmMo (first half value layer (minimum): 0.39 mmA1) or 0.02 mmRh (first half value layer (minimum): 0.47 mmA1), when tube voltage is set at 39 kV, 0.02 mmRh (first half value layer (minimum): 0.49 mmA1). Here, the first half value is measured by using Aluminum plate wherein the purity of Aluminum is more than 99.9%.

(0041)

Output rating of X-ray high voltage apparatus is 2.8 kW (30kV, 92 mA, 6.0 second). The setting condition for X-ray exposure range on the X-ray high voltage apparatus is as follows. The setting range for kV is from 22 kV to 39 kV (1 kV step) and that of mAs is from 2 mAs to 600 mAs.

(0042)

Automatic Exposure Control (AES) function is available in every photographing method such as contact photographing, conventional macrophotograhing and bucky photographing. Automatic Exposure Control functions within the range from 24

kV to 34 kV in kV setting, from 2 mAs to 600 mAs in large sized focal point and from 2 mAs to 200 mAs in small sized focal point, both in the controllable mAs ranges and film density can be set by 15 steps.

(0043)

In X-ray exposure control, an automatic kV/mAs control, kV pre-setting/automatic mAs control and kV/mAs pre-setting are available.

(0044)

The X-ray exposure interlock system works when any one of following abnormal situation is detected, in the rotary anode in X-ray tube, in power supply of main inverter or high voltage circuit, when Mo/Rh filter is not located at specified position, when Automatic Exposure Control (AEC) is selected, when the setting is out of range for possible photographic condition, when a temperature sensor of X-ray tube case works, when X-ray focal point size does not consistent with irradiation field limit plate or when an optical irradiation field mirror is not sheltered.

(0045)

A photographic table, as a result of C shaped arm movements, its stroke, up and down, is about 69 cm (electrically powered), in regards to a rotation angle: 180°-

-(minus) 150° (1° step), the rotation angle can be set in manual mode by using a position setting switches located on the side plate of C shaped arm also by using switch CC, ML and MLO on the photographic stand automatically in automatic mode.

(0046)

Model name of X-ray tube apparatus is DRX-B3856HD-Mo, focal point size is 0.1 mm in small size focal point, 0.3 mm in large size focal point, an anode plate material is Mo (molybdenum), a target angle is 10° in small size focal point, 10° in large size focal point, number of rotation of anode plate is 9700 rpm, maximum thermal capacity for an anode plate is 300 kHU (210 kJ), X-ray radiation slot is made of Be (beryllium), and intrinsic filter is about 1.0 mmBe.

(0047)

Connection cables: between photographing unit and X-ray unit (control unit) is about 9 m in effective length, between X-ray high voltage unit (X-ray operation panel) and X-ray high voltage unit (control unit) is about 9 m in effective length and between power switchboard and X-ray high voltage unit (control unit) is about 9 m in effective length.

(0048)

Power source condition: singe-phase alternating current

power rated power voltage is 200 V, 208 V, 220 V, 230 V and 240 V and the frequency of power supply is 50 Hz or 60 Hz, a maximum permissible voltage fluctuation is 10 % of rated voltage, a permissible power line impedance is less than 0.33 ohms when 200 V, less than 0.34 ohms when 208 V, less than 0.36 ohms when 220 V, 0.38 ohms when 230 V and less than 0.4 ohms when 240 V. And recommended capacity for power supply is about 4.1 kVA. Maximum alternating current power supply is 20.5 A when voltage is 200V - (minus) 10% (180V)

(0049)

Grounding (earth) condition should conform to D-class grounding (earth) construction in (The technical standards of electrical equipment by Ministerial ordinance)

(0050)

Required ceiling height is 230 cm.

(0051)

In regards to environmental condition, ambient temperature is from 10° to 40° Celsius, relative humidity is from 30 to 85 % (non-condense)□air pressure is from 70 to 106 kPa, and as to storage condition, ambient temperature is from -(minus) 10 to 60° Celsius, relative humidity is from 10 to 90% (non-condense) and air pressure is from 50 to 106 kPa.

(0052)

In regards to the condition for use and storage of the apparatus, following item from item (a) to item (m) should be avoided for the use and storage conditions. (a) Out of environmental condition specified above, (b) place filled with harmful gas (c) high humidity place such as place filled with steam, (d) a place where water drop is dripping to the apparatus, (e) dusty place including sand, (f) place with much oily steam, (g) place be exposed to salty air, (h) place with explosive gas, (i) place where excessive vibration or impact is expected, (j) a steep place with more than 0.18 radian (10°), (k) place where high fluctuation of power voltage is expected, (l) place where excessive power voltage drop occurs, (m) place where direct sun light is expected. (0053)

Following is the Classification of the apparatus. (1) Classification for protection form for electric shock is Class I, (2) Classification for protection level for electric shock is B-type mounting section, (3) Classification of level for harmful water invasion is normal product, (4) Classification of safety use in the environment of air, inflammable anesthesia gas or oxygen nitrous sub oxide is product not suitable for use in the environment of air, inflammable anesthesia gas or oxygen /nitrous sub oxide. (5)

Classification of operation mode is continuous operation with intermission load.

(0054)

In regard to leak current, under the condition that temperature is 10-40°Celsius, relative humidity is 30-85%, air pressure is 70-106 kPa and power source is normal condition, earth leak current is less than 5mA, armor leak current is less than 0.1mA, An Examinee leak current is less than 0.1mA. In the case of single failure condition, earth leak current is less than 10mA, armor leak current is less than 0.5mA and an examinee leak current is less than 0.5mA.

(0055)

In regards to regulations, the apparatus above conforms following regulations.

(1) JIS (Japanese Industrial Standard) Z-4701-1997 (Medical X-ray apparatus general roles

(2) Ministry of Health and Welfare, Medical Machine No. 149

(3) IEC 60601-1 (1988)/A1 (1995) (General rules for safety of medical electric machine)

(4) IEC-60601-1-1 (1992)/A1 (Requirements for safety of medical electric systems)

(5) IEC 60601-1-2 (1993) (Electro magnetic conformity (EMC))

(6) IEC 60601-1-3 (1994) (Protection for radiation of diagnostic X-ray apparatus

(7) IEC60601-1-4 (1996) (Programmable electric medical systems)

(8) IEC60601-2-7 (1987) (Ed2 (1998) ((conformity)) (Safety of X-ray high voltage apparatus)

(9) IEC-60601-2-45 (1998) (X-ray (radiation) source)

(10) IEC-60601-2-32 (1994) (Individual regulations for safety of X-ray relevant apparatus)

(11) IEC-60601-2-45 (1998) (Safety of mammography unit)

Apparatus conformed regulations described above is used preferably.

(0056)

In this embodiment, as for a radiation image information detection component, following components can be used. A combination of x-ray intensifier foil and silver halide photographic film, a florescent screen with stimulated emission, a radiation image information reader which is so arranged that a scintillator to convert radiation energy to lights and optical semiconductor to read signal are arrayed two-dimensionally, a radiation image information reader which is so arranged that a photoconductor to convert radiation energy to electric signals directly and a semiconductor

device to read the electric signals are arrayed two-dimensionally, a radiation image information reader which is so arranged to form a set or a plurality of the set of sintillator to convert radioactive ray to light and a combination of lens to focus the light on CCD and CMOS, are arrayed, or a radiation image information reader which includes a sintillator to convert radioactive ray to lights and lead the light to CCD or CMOS by an optical fiber to convert into electric signals.

(0057)

In the case of that the radiation image information component is as mentioned above, a radiation dose detector (for example, photo-timer) as a means to detect the radiation dose, may be attached on the back side of the radiation image information detection component. In the case of that the radiation energy can be taken out directly from radiation image information detection component such as flat panel detector, it may be allowed to have same function as radiation dose detector mentioned above on the radiation image information detection component itself without a radiation dose detector.

(0058)

In this embodiment, a combination of X-ray intensifier

foil and a silver halide photographic is called SF-system (screen film system). X-ray intensifier foil includes phosphor using rare earth element such as calcium tungsten and gadolinium oxide sulfide, and converts radiation energy to light emitted in blue or green. Especially, as for a sensitizing paper using a phosphor using rare earth element, the technologies are described in Japanese published patent application 6-67365 may be used. A silver halide photographic film having photosensitive emulsion applied on one side or both side of the film support is preferable. Especially in the case of a double emulsion film, it is desirable to use photosensitive material with different photographic characteristics on each emulsion layer which sandwiches the film support. Also it is desirable to use a photographic film having an absorption layer to absorb crossover light in between both sides of the emulsion layer of a double emulsion film. In this embodiment, from 8 X 10 inch to 20 X 24 inch sized paper, any size of paper in between, can be used. These silver halide photography material is outlined in TOKKAIHEI 6-67365 and, for example, Principal of Photographic Science and Engineering (Corona Publishing Co., Ltd, authored by The Society of Photographic Science and Technologies of Japan). In regard to photographic process, it is possible to improve

an average gradation by raising the temperature of photographic process or extending the process time, however, principally, it is desirable to follow the specified photographic process by the filmmaker.

(0059)

What is called stimulated emission type fluorescent screen is the screen from which visible ray emission is induced corresponding to the X-ray intensity irradiated, by irradiating visible ray or infrared ray to the screen after the X-ray irradiation. In other words, Putting the stimulated emission type fluorescent screen on and moving the fluorescent screen to laser reader apparatus to read simulated emission after irradiating X-ray to the fluorescent screen then converting the emitted light to electric signal by a photo multiplier results in to obtain the electric signals of radiation image. After the electric signals (image data) are processed properly, it is displayed on image display means such as monitor, etc, or hard copied through image output means such as laser imager. When macro-photographing, the image can be displayed automatically in about real size on monitor display or hard copied by specifying the magnifying power in advance. Regarding a stimulated emission type fluorescent screen for radiation

image information detection component, the fluorescent screen and stimulated emission read-out, en-visible technologies, disclosed in TOKUKAI 2000-245721, can be used in this embodiment.

(0060)

In regards to the radiation image information detection components converting radiation to electric signals explained above, they are disclosed in TOKUGANHEI 11-49080 or Handbook of Medical Imaging Volume 1, Chapter 4 Flat panel imager for digital radiography (ed. R. V. Matter etc., SPIE Press, Bellingham, 2000) and can be used in this embodiment. In these cases, radiation image information detection component can be functioned as well as a detector for radiation dose and electric signals of radiation image obtained by the radiation image information detection component can be processed properly and displayed on the monitor or hard-copied for medical image diagnostics.

(0061)

Furthermore, when macro photographing, in phase image photographing, to obtain a phase contrast image, it is possible to display the obtained a radiation image on the monitor or hard-copied on a photographic film in about real size automatically.

□0062□

In regard to methods of hardcopy, an image development using silver halide photographic sensitive material to obtain the image by an image development, an image development by heating after exposure by laser ray corresponding to the radiation image information and heating corresponding to the radiation image information etc are preferable embodiments. Also a solid inkjet record method which jets liquid state material from the nozzle to draw the image at room temperature, a inkjet recording method which jets liquid such as dye or color at room temperature from a nozzle to draw the image, a method to draw the image by fixing the ink sublimated on the ink ribbon by heating to draw the image and an ablation image forming method by evaporating carbon applied all over a sheet by irradiating laser ray according to the image information, are used to make hard copies.

(0063)

Also, a control unit is equipped with the radiation image photographic apparatus 1 in this embodiment. A radiation source 6, a pressure board 11, an absorption contrast image support table 13, a driving device of a phase contrast support table 14 and a radiation operation panel 37 as an input device to specify the photographic mode are

connected to this control unit. A key to specify a mode selectively on the radiation operation board 37, which includes "normal photographic mode" which is done by attaching a radiation image information detection component 20 to an absorption contrast image support table 13, "first phase image photographic mode" which is done by attaching a radiation image information detection component 20 to phase contrast photographic support table 14a, "second phase image photographic mode" which is done by attaching a radiation image information detection component 20 to the phase contrast photographic support table 14b, "normal photographic mode" done by a absorption contrast image support table 13 and "a plural of phase image photographic mode" which corresponds to different kinds of magnification. Further, as an input device, a keyboard, a magnetic card reader, a bar code reader a HIS (Hospital Information Systems) etc may be utilized, and which may be provided separately from the radiation operation panel 37.

(0064)

Also, an Image output unit to transfer photographic image to a printer etc and or an image display unit to display the image are connected to the operation board.

(0065)

[EFFECT OF THE INVENTION]

As mentioned above, according to the invention described in Claim 1, as a supporting unit with a phase contrast image support table attached, is detached (move or remove freely) to the core of mammography unit, when photographing an absorption contrast image, in other words, when a phase contrast image support table is not used, it is prevented that the phase contrast image support table becomes an obstacle to the examinee, accordingly the burden to the examinee can be decreased.

(0066)

According to the invention described Claim 2, as the weight of supporting unit is so light as less than 30Kg, the workload to detaching can be decreased and the detachable work can be done safely.

(0067)

According to the invention described in Claim 3, having a grip handle on the supporting unit can make the workload decreased and the detachable work done safely.

(0068)

According to the invention of Claim 4, the supporting unit and the mammography unit are connected electrically so that a status of the supporting unit, attached or detached,

can be easily detected at the mammography unit in the case of that a sensor to detect the supporting unit attached on or detached from the mammography unit, and accordingly a malfunction can be prevented. Furthermore, the phase contrast image support table attached on the supporting unit can be controlled from the mammography unit by remote control operation, also the phase contrast image support table can be moved to a certain position or evacuated when it is not used. (0069)

According to the invention of claim 5, when an absorption contrast image is photographed, in other words, when the phase contrast support table is not used, it can be evacuated to the space to prevent to be an obstacle to the examinee, accordingly it reduces a load factor to attach or detach the phase contrast support table to the supporting unit.

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is a side elevation of a radiation image photographic apparatus.

FIG. 2 is a side elevation of a mammography unit.

FIG. 3 is a perspective view of a supporting unit.

FIG. 4 is a perspective view of another embodiment of a supporting unit.

FIG. 5 is a side elevation of a radiation image photographic apparatus to show an electric connection of a supporting unit.

[Explanation of notation]

1 radiation image radiographing apparatus

2 mammography photographing apparatus

6 X-ray source

10 photographic object table

13 absorption contrast image support table

14 phase contrast image support table

20 radiation image information detection component

[NAME OF THE DOCUMENT] Drawings

FIG. 1

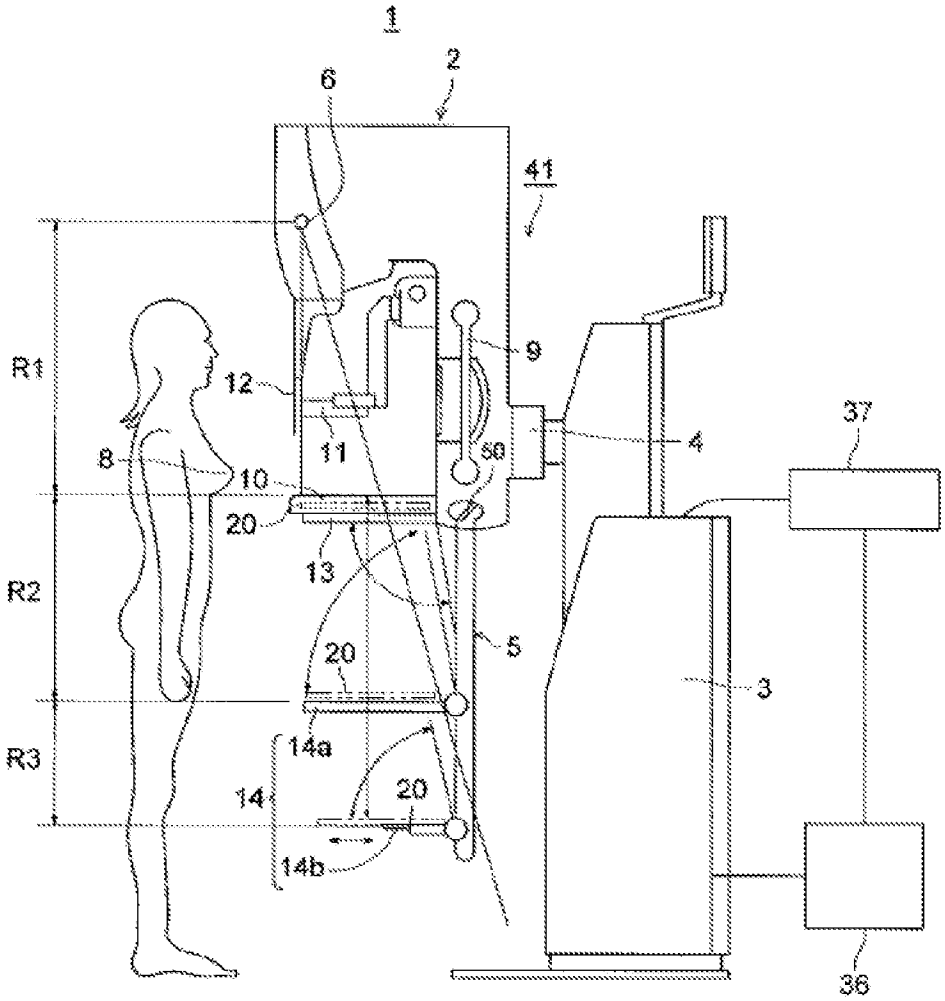


FIG. 2

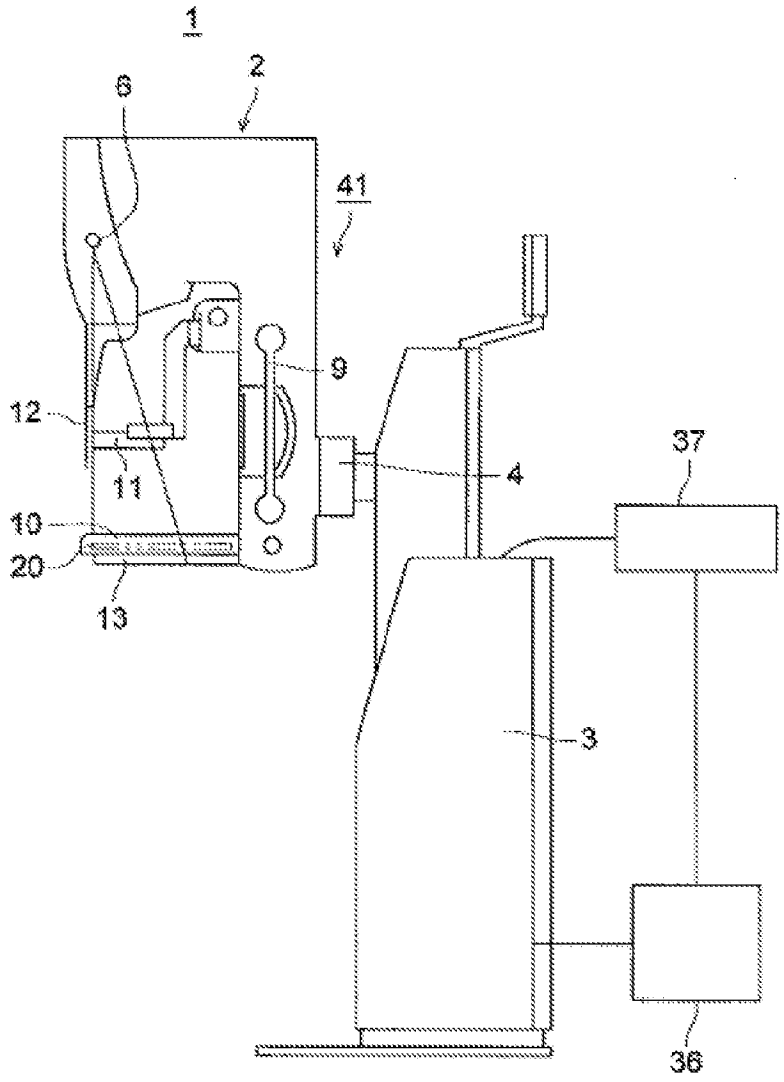


FIG. 3

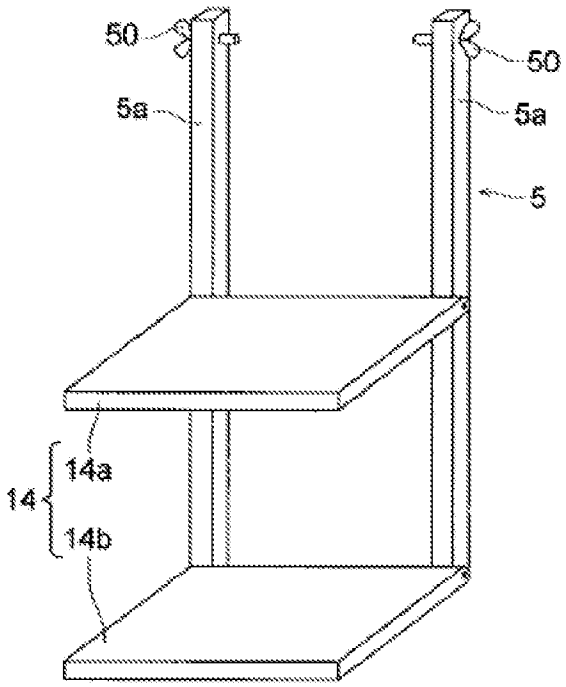


FIG. 4

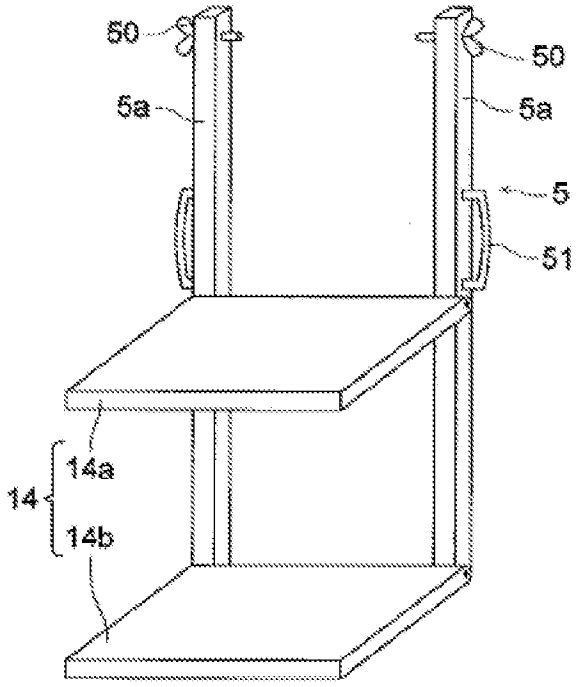
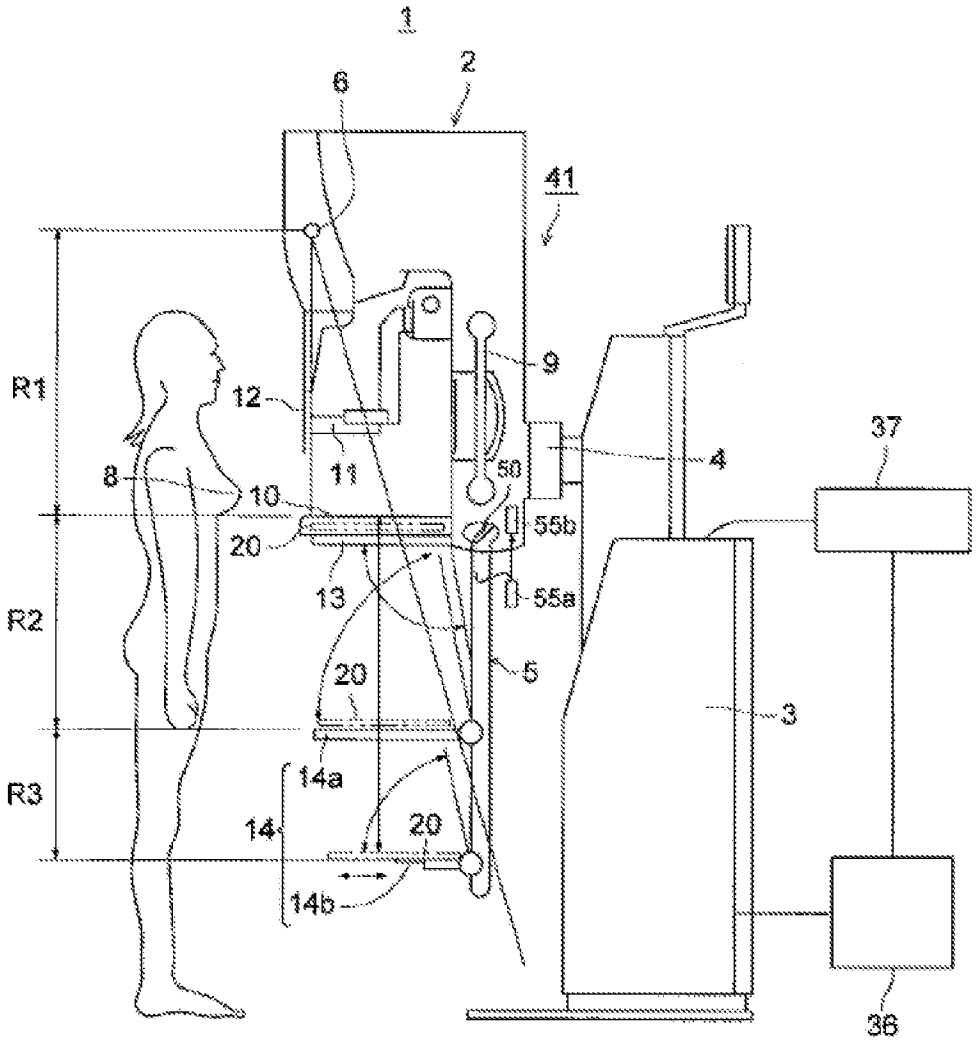


FIG. 5



[NAME OF DOCUMENT] ABSTRACT

[ABSTRACT]

[OBJECTIVE] To provide a radiation image photographing apparatus having the above drawback obviated and a detection component support table set at a location where the existence of the detection component support table to hold the radiation image information detection component for phase contrast photographing not to be an obstacle to the examinee and decrease the examinee's burden.

[SOLVING MEANS] There is provided a photographic object table 10 supporting a photographic object so that face to face against a radiation source 6; a radiation image information detection component 20 detecting a radioactive ray passing through the photographic object; an absorption contrast image support table 13 supporting the radiation image information detection component arranged to locate the radiation image information detection component at vicinity to the photographic object table and on opposite side of the radiation source for the photographic object when photographing an absorption image; and a phase contrast image support table 14 supporting the radiation image information detection component with a certain distance from the photographic object table arranged to locate the radiation image information detection component on the opposite side of the radiation source for the photographic object and at least a part of the radiation image information detection component is exposed inside irradiated area of the radiation source; a phase contrast image support table equipped with a supporting unit is attached detachably to a mammography unit.

[SELECTION OF DRAWINGS] Fig. 1